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# ELECTRIC POWER DEVELOPMENTS IN THE KRASNOYARSK/ZAOZERNYY/DODONOVO TRIANGLE, USSR

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# ELECTRIC POWER DEVELOPMENTS IN THE KRASNOYARSK/ZAOZERNYY/DODONOVO TRIANGLE, USSR

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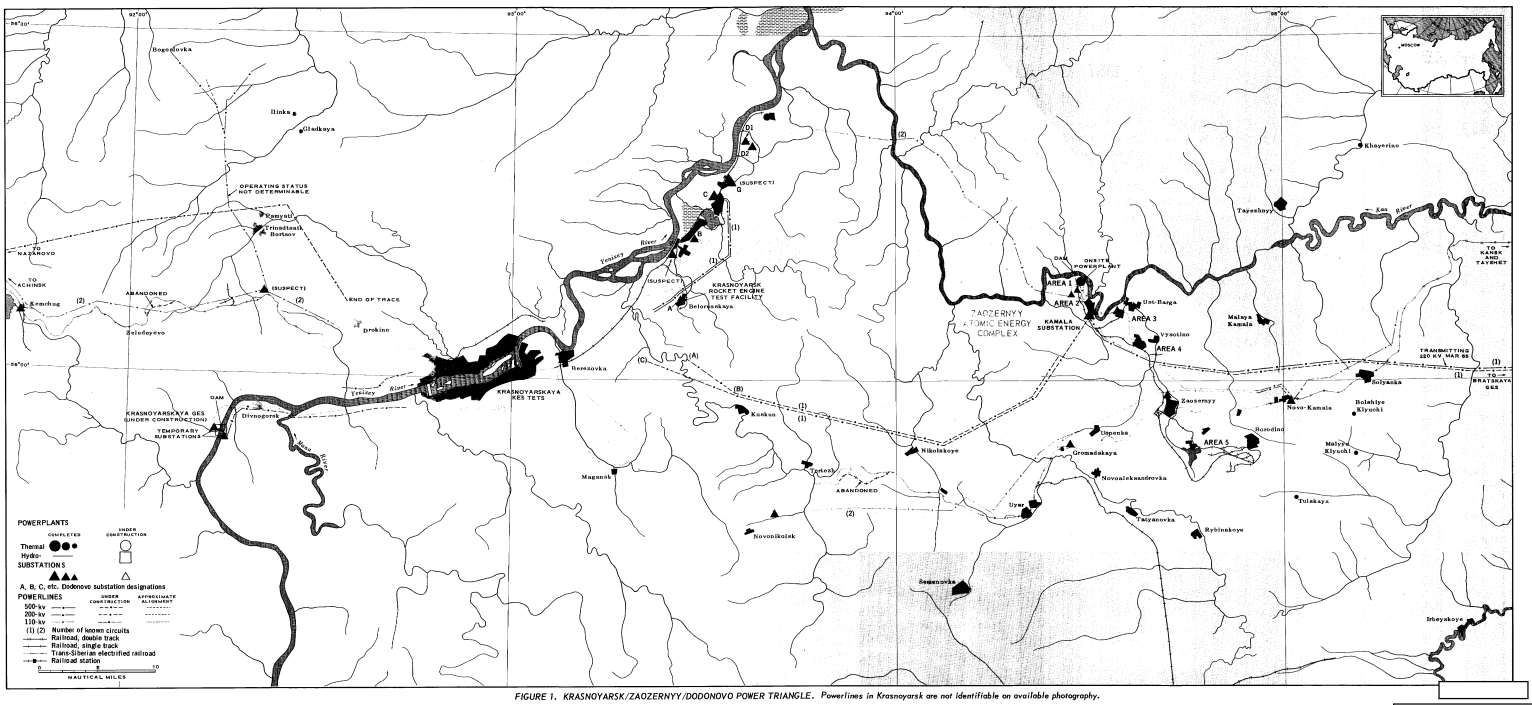



*FIGURE 1. KRASNOYARSK/ZAOZERNYY/DODONOVO POWER TRIANGLE. Powerlines in Krasnoyarsk are not identifiable on available photography.*

probably planned for future transmission of 500-kv power in a single circuit, photography showed that 500-kv transformers had not yet been installed at Kamala Substation. This indicates that 220-kv rather than 500-kv power is still being transmitted over the powerline (Figure 1).

The photography indicates a probability that no 500-kv power will be made available to Kamala Substation from the west until Krasnoyarskaya GES goes into service and begins generating 500-kv power, or until a 500-kv switching yard at Krasnoyarskaya GES is placed in service and is served by 500-kv power coming from farther west.

Recent photography shows no change in the 500-kv powerline trace which was identified in 1963 as extending westward from Kamala Substation through Point B (55-59N 93-32E) northwest of Kuskun to Point A (56-02N 93-28E) near Krasnoyarsk and the Dodonovo Atomic Energy Complex (Figures 1 and 2). The trace changes direction at Point B. However, photography showed that supports are installed for a 500-kv powerline up to Point B and that a second trace is being cut westward from Zaozernyy toward Point B and then beyond at a divergent angle from the first. The new trace is also for a 500-kv powerline, which has been cut to Point C (56-01N 93-21E) east of Krasnoyarsk.

## 220-KV POWERLINES

A 220-kv power grid is under development in the area of Krasnoyarsk and the Dodonovo Atomic Energy Complex and extends to Nazarovo west of the triangle. There is no evidence on recent photography that this grid is to be extended to the Zaozernyy Atomic Energy Complex. The poor quality of available photography covering Krasnoyarsk limits any firm analysis of the circuits in the immediate vicinity of the city.

Power at 220 kv is supplied to the main substation (Substation C) of the Dodonovo Atomic Energy Complex from Krasnoyarskaya KES TETS, over a probably 2-circuit powerline. Photography of also shows a trace, probably for a 220-kv line, cut from the western limits of Krasnoyarsk to a point just west of Divnogorsk, the construction town for the building of the Krasnoyarskaya GES, a hydroelectric powerplant. Eventually the 220-kv circuits to be installed in this trace will be tied into a 220-kv switching yard to be constructed for the Krasnoyarskaya GES on the right bank of the Yenisey River. 2/

## 110-KV POWERLINES

An extensive network of 110-kv powerlines, most of which appear to have 2 circuits, serves the Krasnoyarsk/Zaozernyy/Dodonovo triangle. The 110-kv power grid in the triangle provides some flexibility in the event of an outage caused by powerline failure. Both the Zaozernyy and Dodonovo Atomic Energy Complexes are supplied internally over these 110-kv facilities; a 2-circuit powerline directly connects the complexes.

A 2-circuit 110-kv powerline, which provides power for the electrified Trans-Siberian Railroad, generally parallels the railroad through the Krasnoyarsk/Zaozernyy/Dodonovo triangle. Indirectly the railroad powerline can also feed power in small amounts to the complexes.

# POWERPLANTS

Electric power for local use in the Krasnoyarsk/Zaozernyy/Dodonovo triangle is generated by the Krasnoyarskaya KES TETS, a thermal powerplant located in Krasnoyarsk and having a reported capacity of 424 MW; the onsite thermal powerplant at the Zaozernyy Atomic Energy Complex and having a reported capacity of 400 MW which is being enlarged; and a small thermal power/steamplant at the Dodonovo Atomic Energy Complex. 4-6/ Krasnoyarskaya GES, a large hydroelectric powerplant and dam under construction on the Yenisey River upstream from Krasnoyarsk, is planned to generate power for both the UHV system and the Krasnoyarsk 220-kv power grid.

The Krasnoyarsk/Zaozernyy/Dodonovo triangle is becoming an important consumer in the exploitation of the hydroelectric power resources of major Siberian rivers, notably the Yenisey and the Angara. A "guaranteed" 9,000 to 12,000 MW of hydrogenerated power is expected to be available to the central Siberian UHV grid when all of the hydroelectric powerplants are completed for the Angara River cascade. 7/ By the middle of 1965, however, only a small percentage of this potential capacity was available in the triangle. For example, the Kamala Substation at the Zaozernyy Atomic Energy Complex could draw only a limited amount of the power being generated by Bratskaya GES on the Angara River. The isotope separation plant at the Zaozernyy Complex is and will be largely dependent on the 500-kv grid for power, currently suppled from sources outside the triangle, supplemented by power generated at the onsite powerplant.

## KRASNOYARSKAYA GES

Krasnoyarskaya GES (55-56N 92-16E; is the first unit started in the planned cascade of major hydroelectric plants along the Yenisey River. The site is a gorge about 19 nautical miles (nm) upstream from Krasnoyarsk (Figure 1). On the right (east) bank of the river near the site is the new town of Divnogorsk which houses construction workers. The town is probably planned as the nucleus of an industrial complex similar to those already in existence near other Soviet hydroelectric powerplants, such as at Bratskaya GES.

The dam and the powerplant are still under construction. By the river had been completely blocked from shore to shore by construction activities, and water was flowing through temporary flumes in the completed part of the dam structure. A gravity dam of reinforced concrete is planned to raise the river level to provide an average head of 260 feet. 7/ The powerplant is to have 12 Francis-type turbogenerators, each having an installed capacity of 292 MW, or a total of 3,504 MW. 7/

## KRASNOYARSKAYA KES TETS

The Krasnoyarskaya KES TETS (56-01N 93-02E; is a regional condensing thermal powerplant serving the city of Krasnoyarsk, the Dodonovo Atomic Energy Complex, and the Trans-Siberian Railroad (Figure 3). The powerplant is located on the right (south) bank of the Yenisey River in the eastern part of the city (Figure 1).

Adverse atmospheric conditions prevailing on all aerial coverage of the urban area of Krasnoyarsk prevent a firm analysis of equipment installed in the switching yard, the alignments of powerlines, or a determination of the circuitry (Figure 3). However, unclassified ground photography of the powerplant reveals steel or aluminum lattice supports for both 110-kv and 220-kv powerlines which can carry 2 circuits.

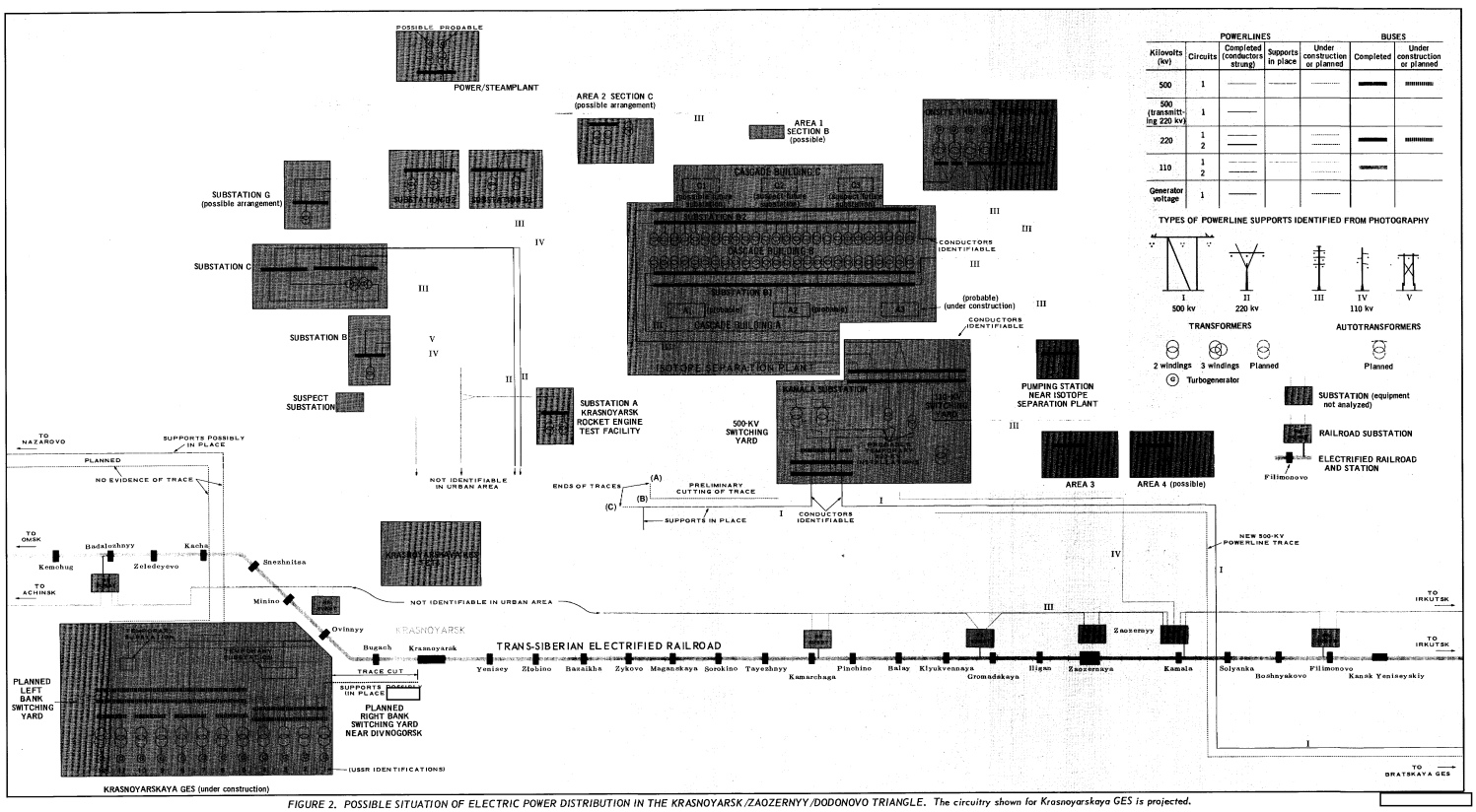



*FIGURE 2. POSSIBLE SITUATION OF ELECTRIC POWER DISTRIBUTION IN THE KRASNOYARSK/ZAOZERNYY/DODONOVO TRIANGLE. The circuitry shown for Krasnoyarskaya GES is projected. Railroad station names are taken from USSR timetables. 12/*


FIGURE 3. KRASNOYARSKAYA KES TETS,

Coolant water for the powerplant is pumped from the Yenisey River and is discharged into the river. In winter when the Yenisey is frozen, a channel of open water has been observed extending downstream from the hot water discharge point toward the Dodonovo Atomic Energy Complex before the effluent heat has dissipated. 4/

## ONSITE THERMAL POWERPLANT, ZAOZERNYY COMPLEX

The onsite thermal powerplant (56-09N 94-29E; in Area 1 of the Zaozernyy Atomic Energy Complex has been undergoing almost continual construction and expansion since the powerplant was first observed in (Figures 4 and 5). The powerplant's expansion indicates that the isotope separation plant at the atomic energy complex is to have a locally available thermal generated power capacity similar to that provided the gaseous diffusion plant from its onsite powerplant at the Angarsk Atomic Energy Complex and the Verkh-Neyvinskiy Gaseous Diffusion Plant from the large thermal powerplant in Verkhniy Tagil. However, the isotope separation plant will probably depend primarily on power from the UHV grid, rather than on the powerplant.

Photography of early 1965 provides evidence that construction has begun on a new, third section for the plant. Measurements of the construction indicate that high-capacity turbogenerators may be installed. A third stack under construction will have a concrete footing or foundation approximately in diameter. This stack is not aligned with those for Sections 1 and 2. The overall width of Section 3, judging from the site being cleared for it, will be somewhat greater than those of Sections 1 and 2 (Figure 4). The distance between the south wall of the existing generator hall and the third stack under construction is approximately 400 feet (about 128 meters). This dimension compares closely with those of Soviet designs for powerplants having 200-MW turbogenerators and 300-MW turbogenerators (Figures 6 and 7). 8/ The powerplant's 7 turbogenerators deliver generator-voltage power to 7 step-up transformers positioned along the south wall of the generator hall in unit A of the switching yard, which is divided into 5 separately secured units, designated A through E (Figure 4).

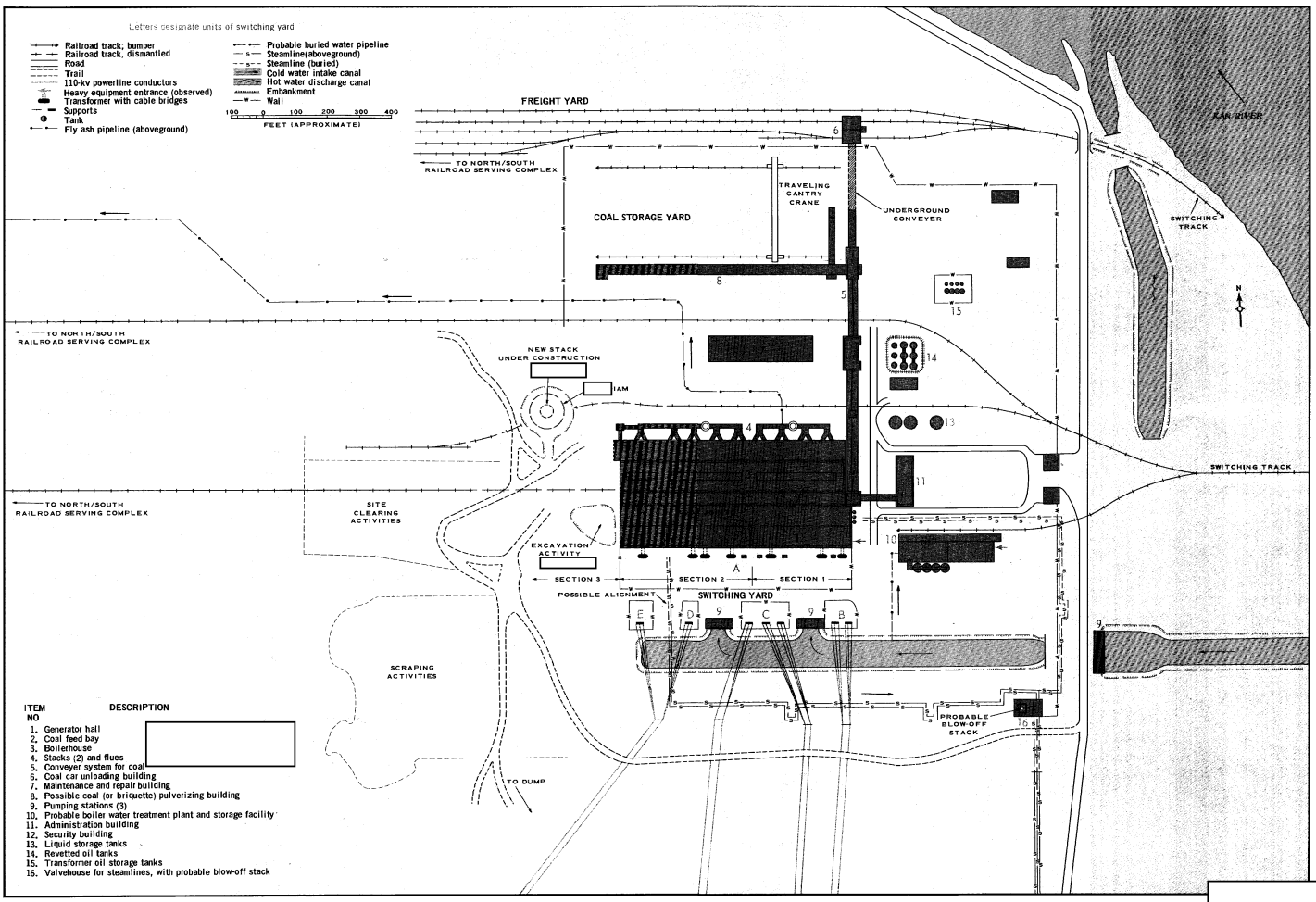



*FIGURE 4. ONSITE THERMAL POWERPLANT (AREA 1), ZAOZERNYY ATOMIC ENERGY COMPLEX.*

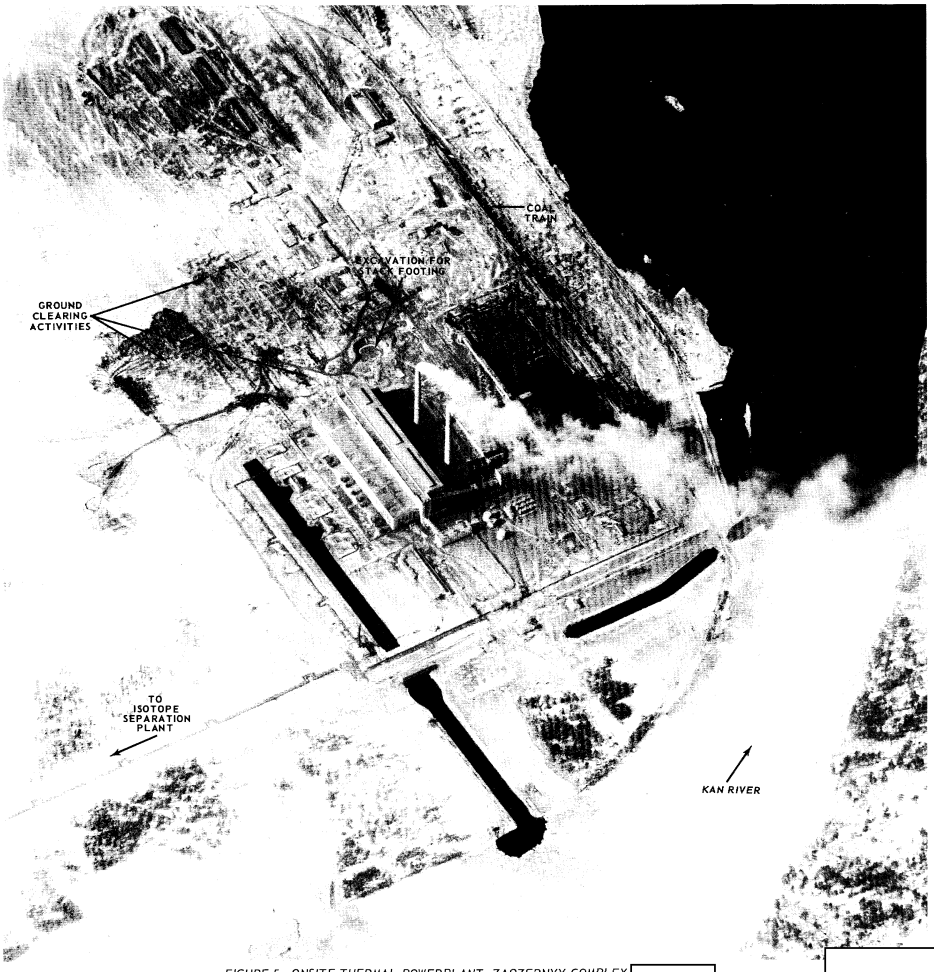



FIGURE 5. ONSITE THERMAL POWERPLANT, ZAOZERNYY COMPLEX.

The greatly improved quality of recent photography of the onsite thermal powerplant permits a better appraisal of the functions of auxiliary structures and facilities attached to the powerplant. An administration building (item 11, Figure 4) is located about 150 feet east of the boilerhouse and generator hall. An overhead enclosed passageway connects the 2 buildings. A newly identified probable boiler water treatment plant and storage facility (item 10) is located about 150 feet east of the generator hall and just south of the administration building. Four vertical tanks are set along the south wall of this facility. A scar indicating a probable buried water pipeline can be traced from the intake canal to the western end of the probable boiler water treatment plant (Figures 4 and 5). Liquid storage tanks (item 13) and revetted oil tanks (item 14) are located east of the coal conveyer system (item 5). Eight tanks for transformer oil storage (item 15) are in a small secured area east of the coal conveyer system. A maintenance and repair building (item 7) is located north of the 2 completed 500-foot stacks for Sections 1 and 2 of the powerplant.

The 1965 photography revealed a traveling gantry crane serving the coal storage yard with a long narrow structure (item 8) along the yard's southern boundary. This facility performs the final processing of coal, possibly coal or briquette pulverization. The building is directly connected to the coal conveyer system. Pulverizing machinery would reduce the coal or briquettes to a fine powder which would then be moved through the coal feed bay (item 2) to the boiler furnaces. The building had been identified from the poor-quality photography of [redacted] as a coal-thawing facility.

The coal mined in Area 5 of the Zaozernyy Complex south of Borodino is probably of poor quality. 9, 10/ The fuel may be processed first in Area 5, and further processed in Area 4. The resultant processed fuel would then be delivered by rail to the freight yard on the northern side of the coal storage yard in Area 1, possibly in the form of molded briquettes.

[redacted] photography showed a train of 21 loaded probably hopper cars; a locomotive was on one of the tracks (Figure 5). The train was probably ready to begin being unloaded. Hoppers or open gondolas are switched through a 2-track coal car unloading building (item 6) where the

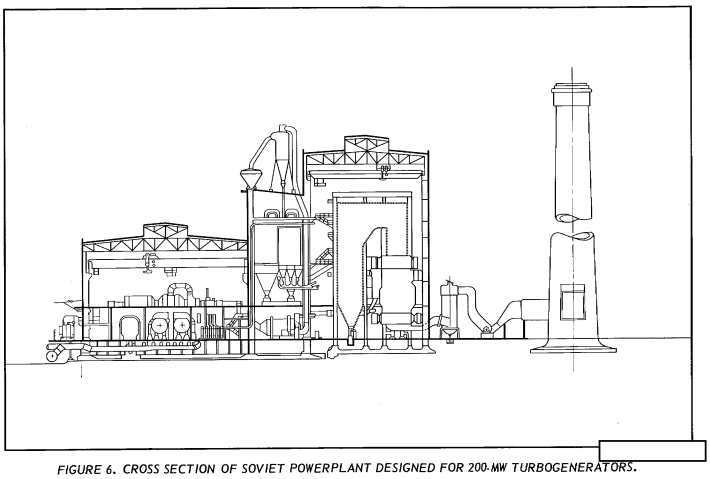


FIGURE 6. CROSS SECTION OF SOVIET POWERPLANT DESIGNED FOR 200-MW TURBOGENERATORS.

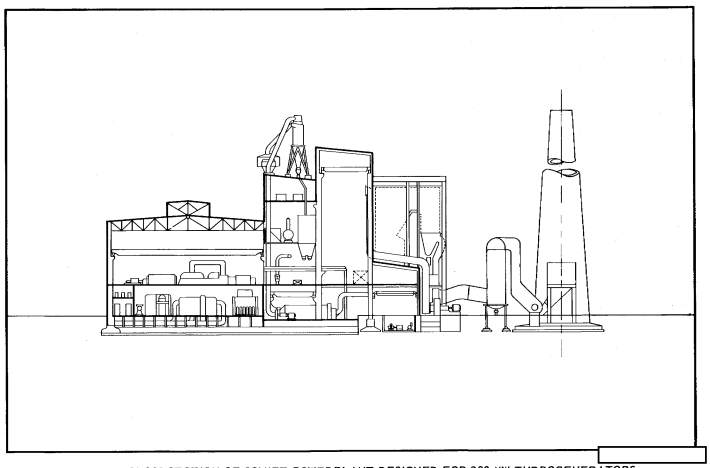


FIGURE 7. CROSS SECTION OF SOVIET POWERPLANT DESIGNED FOR 300-MW TURBOGENERATORS.

coal is delivered to the conveyer system (Figures 4 and 5). The lack of any large amounts of coal stored in the coal storage yard in suggests that this facility is in a standby or inactive status.

## POWER/STEAMPLANT, DODONOVO COMPLEX

A small coal-fired power/steamplant has been identified in the Northern Operational Area of the Dodonovo Atomic Energy Complex (Figure 8). The installation includes coal-handling facilities, a small combined boilerhouse/generator hall, a single stack, and a small switching yard on the south side of the generator yard. Power generated at this power/steamplant provides backup power not only for adjacent facilities but also for the pumping station near the water intake on the Yenisey River (Figure 9).

# SUBSTATIONS

Major transformer substations and switching yards in the Krasnoyarsk/Zaozernyy/Dodonovo triangle are the Kamala Substation at the Zaozernyy Atomic Energy Complex and Substation C at the Dodonovo Atomic Energy Complex. Two long substations (Substations B1 and B2) serve Cascade Building B of the isotope separation plant in the Zaozernyy Complex. Smaller transformer substations are also found at the atomic energy complexes and elsewhere in the triangle, notably along the Trans-Siberian Railroad. Switching yards are found at powerplants. Substations in the city of Krasnoyarsk cannot be described because of the poor quality of the photography of the city; substations at Krasnoyarskaya GES were observed. Possible circuitry in some substations is shown in Figure 2.

## ZAOZERNYY ATOMIC ENERGY COMPLEX

The largest potential consumer of electric power in the Krasnoyarsk/Zaozernyy/Dodonovo triangle is the Zaozernyy Atomic Energy Complex with its isotope separation plant (Figures 10 and 11). 10/ The largest substations in the triangle are located within the area of the isotope separation plant.

Kamala Substation. This is a major transformer substation on the UHV grid (Figures 12 and 13). 11/ The substation is located in Area 2--the isotope separation plant--at the Zaozernyy Complex and just east of the plant. It is 18 nm northwest of the community of Novo-Kamala and Kamala Station on the Trans-Siberian Railroad (Figure 1). 12/ Kamala Substation in Area 2 should not be confused with the substation at Kamala Station serving the railroad (Figures 1 and 2).

Four 500-kv single-circuit powerlines will eventually be tied into Kamala Substation. Photography of clearly showed conductors (between supports) for 2 incoming 500-kv circuits--one from Bratskaya GES in the east and one from the direction of Krasnoyarsk in the west in the immediate vicinity of the substation. Only the circuit from Bratskaya GES is evidently transmitting power, and probably only at 220 kv (Figures 1 and 2). photography showed that the 500-kv powerline from the direction of Krasnoyarsk was incomplete, although part of the conductors for this powerline have been strung and possibly tied into Kamala Substation.

The substation contains a 500-kv switching yard which is not entirely equipped and a 110-kv switching yard. Two buildings are located northwest of the 500-kv switching yard.

The smaller building is probably the control building for the 110-kv equipment. The larger building will probably be the control building for the 500-kv equipment; this is indicated by trenching leading into this structure from the vicinity of construction activity on the 500-kv transformers (Figure 12). The northeastern corner of the substation is separately secured and contains a transformer maintenance building and a transformer oil storage facility containing 8 vertical tanks. The substation is both road and rail served.

In [redacted] some electrical equipment for the 500-kv switching yard was still being installed. Temporary equipment for 220 kv is probably installed. The southwest corner of the yard is unfenced; this would permit the moving of heavy and bulky 500-kv equipment into the yard. The 500-kv switching yard has 8 switching positions and will eventually have 8 buses. Additional switching equipment to accommodate the incoming 500-kv circuits will have to be installed in the yard. Preliminary work for the installation of 2 banks of 3 single-phase 500-kv step-down transformers is under way. None of these transformers has been observed at the substation. The planned power distribution circuit diagram from Krasnoyarskaya GES to the complex indicates that autotransformers are also planned for Kamala Substation. 2/

The 110-kv switching yard has 22 switching positions. Of these, 4 have no switching or other equipment installed. Wiring is probably incomplete at the west end. Two banks of 3-digit single-phase 220/110-kv transformers, possibly for temporary use, have been installed immediately southeast of the 110-kv switching yard. Framing for a possible third bank is visible. Exactly how 220-kv power is tied into these transformers from the equipment in the 500-kv switching yard is not clear. A possible arrangement of circuitry is indicated on Figure 2.

Substations Serving Cascade Buildings. The isotope separation plant (Area 2) of the Zaozernyy Complex has 4 cascade buildings. Layouts of the buildings and descriptions of their electrical services are based on [redacted] photography (Figure 12). 10/

Cascade Building A was substantially complete, but not all of the electrical equipment was installed. The building has 3 probable substations (A1, A2, and A3) which are in enclosed projections on its southwest side. Probable Substations A1 and A2 each may have two 110-kv tie con-


FIGURE 8. POWER/STEAMPLANT, NORTHERN OPERATIONAL AREA, DODONOVO ATOMIC ENERGY COMPLEX, [redacted]

nections from Substation B1 at Cascade Building B. Probable Substation A3 was under construction in and support framing for only 1 tie connection was installed. However, trenches in the vicinity of this substation possibly indicate that it will also have 2 tie connections. The projections housing the substations are approximately the same size, and each has a row of 6 ventilators on its roof.

Cascade Building B was complete and probably in operation. The building is served by 2 long substations, B1 and B2, which are aligned along the sides of the building. Each substation has 2 parallel buses which transmit 110 kv the length of each substation; the only possibly identifiable low-voltage circuits (not shown) would be those between the transformers and Cascade Building B. An earlier report stated that Substations B1 and B2 handled only low-voltage current. 10/ Switching equipment feeds power from one or the other of the buses in each substation into a row of 26 step-down transformers situated along each side of Cascade Building B. Tap-offs, probably from the outer bus in Substation B1, are or will be tied into the 3 substations at Cascade Building A.

The main structure of Cascade Building C was complete. This cascade building will probably have power service similar to that at Cascade Building A, and it will possibly have 3 substations which may be housed in projections along the northeast side of the building. The projection which may house Substation C1 was structurally nearing completion. This projection is similar to those attached to Cascade Building A, but roof construction had not been completed and roof ventilators were not yet evident. Electrical equipment was possibly being installed. Excavation for the foundations for a suspect Substation C2 was visible. Location of a third substation (C3) can only be conjectured, because no signs of its construction were observed on the photography. Soviet practice, as observed from consecutive and is to add these projections some time after the completion of the main structure of a cascade building.

The construction of Cascade Building D had not proceeded far enough to allow a determination of how electric power was to be tied into its operating equipment.

Switching Yard at Onsite Powerplant. The onsite thermal powerplant (Area 1) at the Zaozernyy Complex

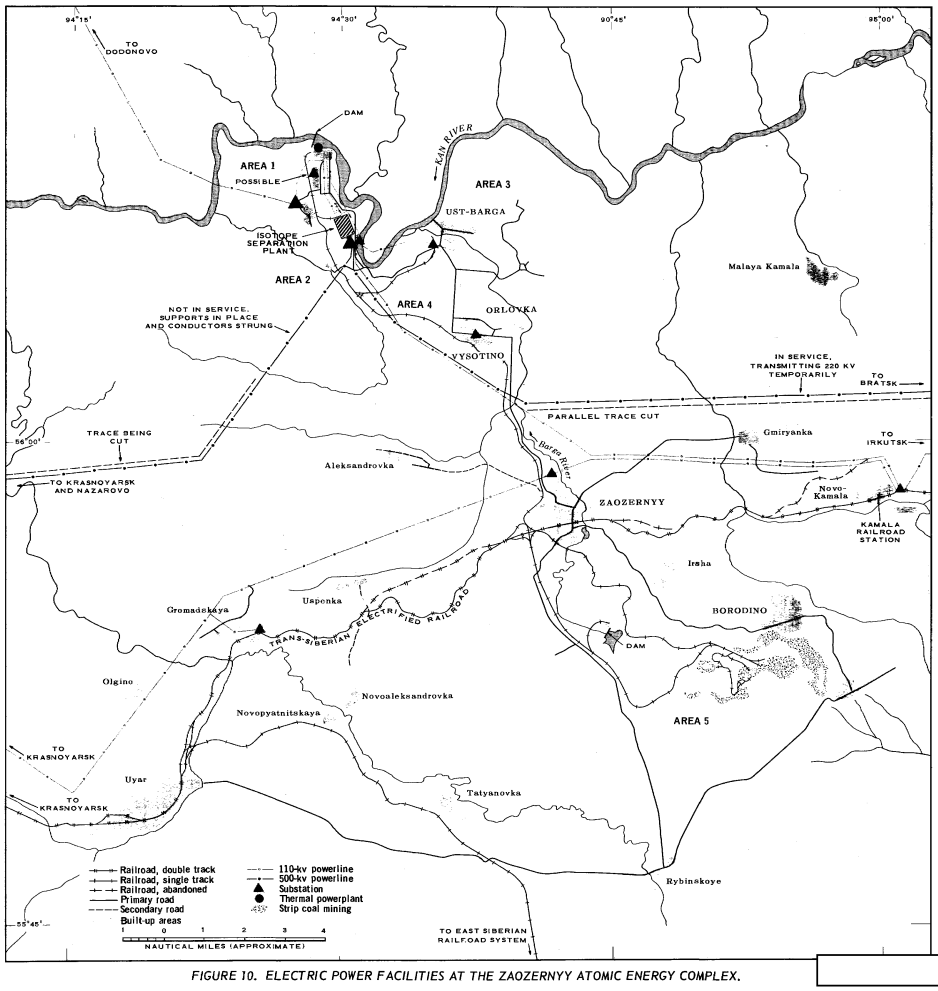



*FIGURE 10. ELECTRIC POWER FACILITIES AT THE ZAOZERNYY ATOMIC ENERGY COMPLEX.*

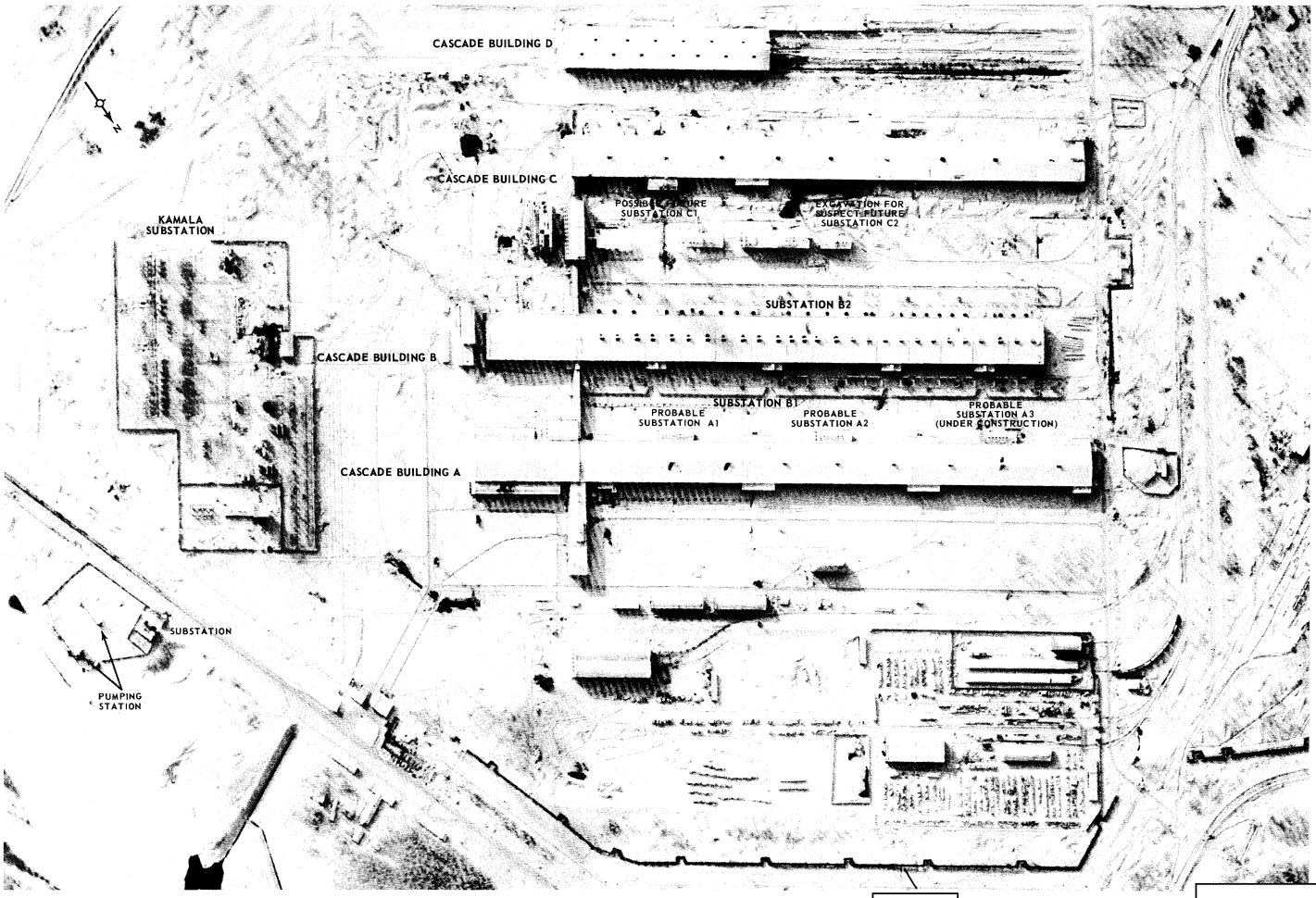



*FIGURE 11. ISOTOPE SEPARATION PLANT AND KAMALA SUBSTATION, ZAOZERNYY COMPLEX,*

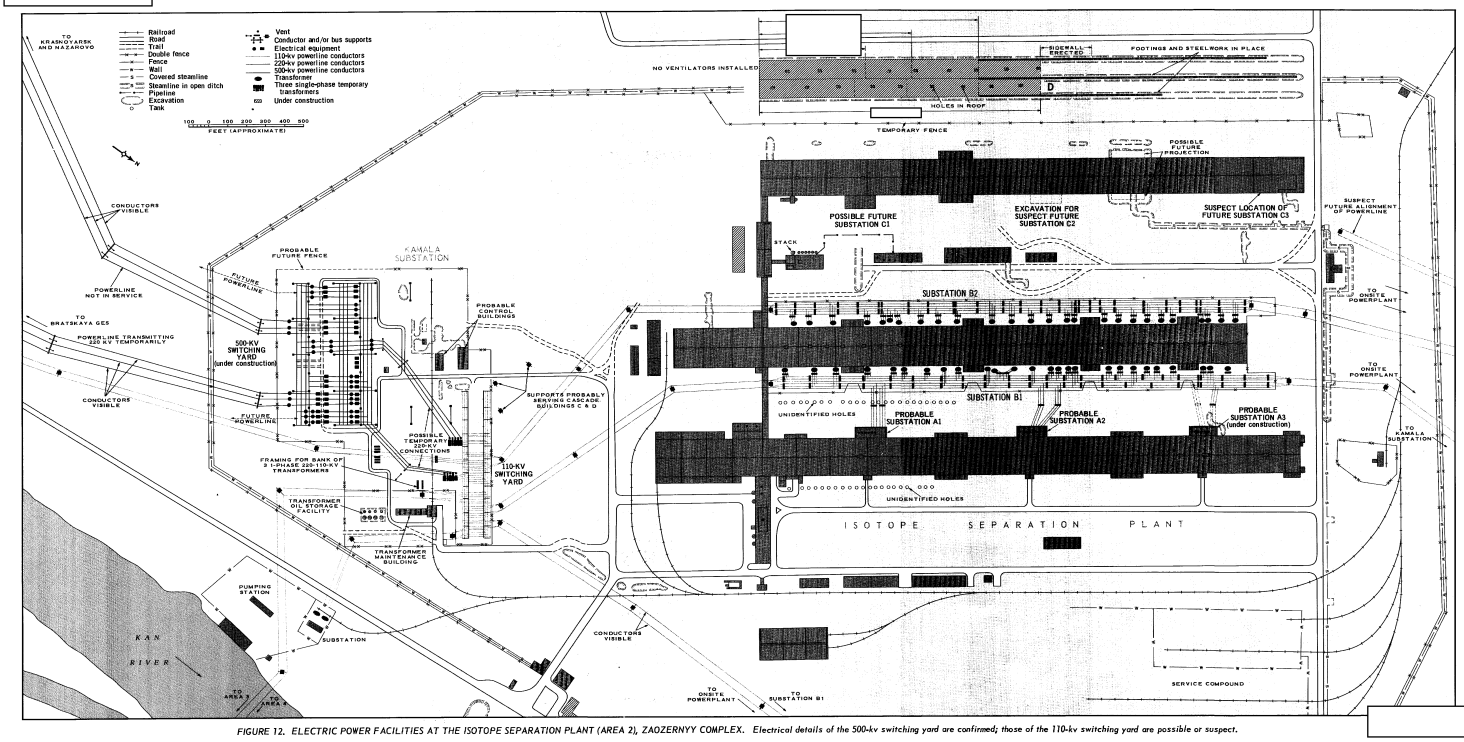



*FIGURE 12. ELECTRIC POWER FACILITIES AT THE ISOTOPE SEPARATION PLANT (AREA 2), ZAOZERNYY COMPLEX. Electrical details of the 500-kv switching yard are confirmed; those of the 110-kv switching yard are possible or suspect.*

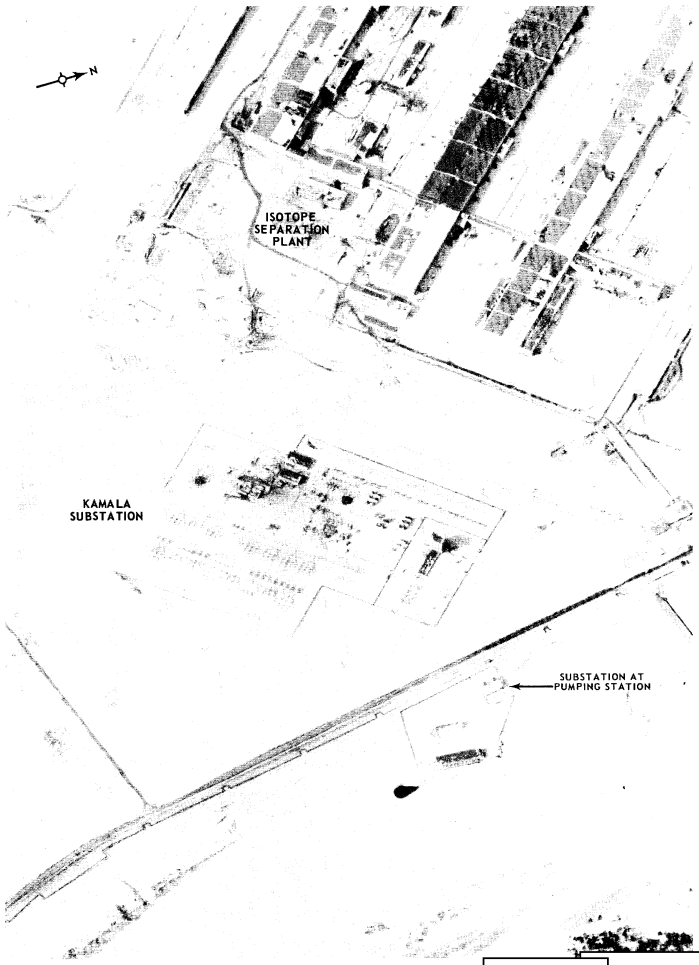



FIGURE 13. KAMALA SUBSTATION, ZAOZERNYY COMPLEX

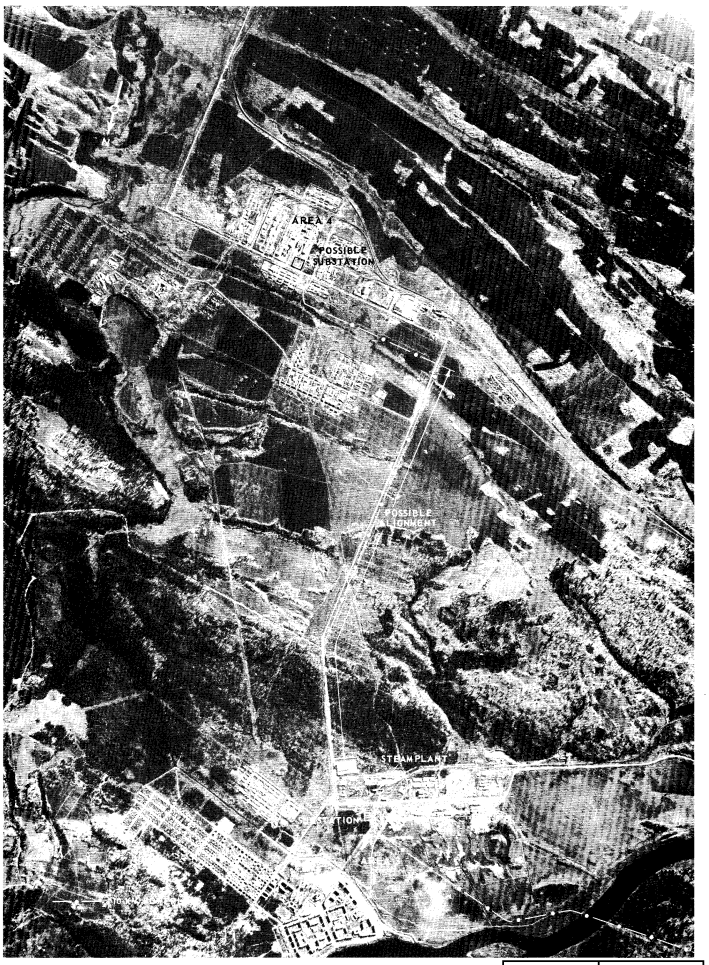



FIGURE 14. SUBSTATIONS IN AREAS 3 AND 4, ZAOZERNYY COMPLEX

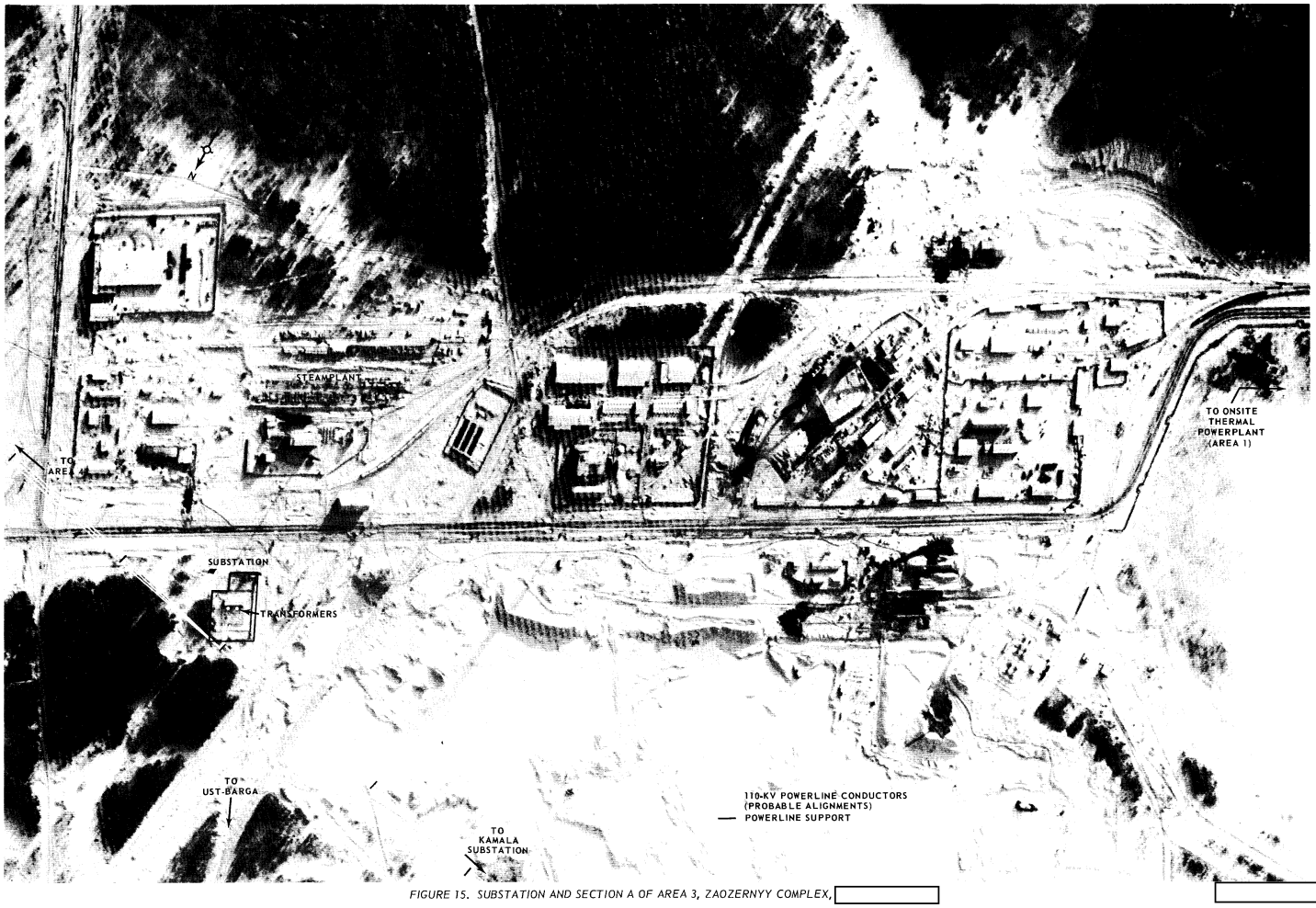



*FIGURE 15. SUBSTATION AND SECTION A OF AREA 3, ZAOZERNYY COMPLEX,*


FIGURE 16. SUBSTATION C IN THE NORTH SUPPORT AREA, DODONOVO COMPLEX,

(Figure 4) has a 110-kv switching yard. This yard is composed of 5 separately secured units, A through E. Two pumping stations (item 9, Figure 4) are situated between units of the yard, and a steamline passes under the west end of Section A of the yard. Supports for 110-kv powerline conductors are in the other 4 separately walled units, B through E. It cannot be determined from photography whether a continuous bus interconnects the switching equipment in these 4 units. Eight 110-kv circuits apparently leave the switching yard (Figures 2 and 4). Despite good-to-excellent [redacted] of the powerplant and the isotope separation plant (Area 2) at the complex, the exact arrangement of these powerlines, their circuits, and their connections to substations within the complex is to some extent conjectural. Changes made during construction of facilities in Areas 1 and 2 partially obscure details.

Minor Substations at the Zaozernyy Complex. A small possible substation is now identified among the support facilities of Section B of Area 1 (Figures 1 and 10). 9/ The quality of the photography does not permit a determination of equipment in this facility.

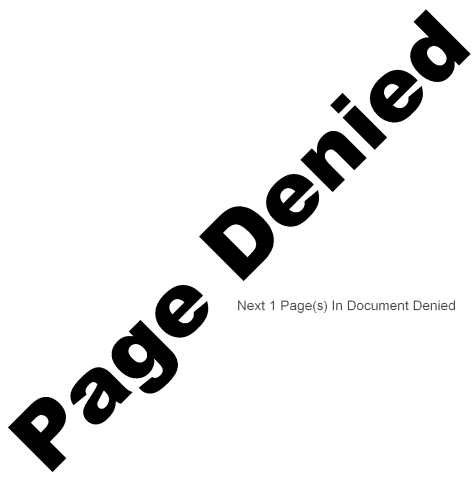
In Area 2, a separately secured substation with 2 transformers is located at the pumping station which provides coolant water for gaseous diffusion operations. The substation is located directly east of Kamala Substation between the river and the principal road which serves the 5 areas of the Zaozernyy Complex (Figures 10 and 12).

A small secured substation with 2 small transformers in the northwest corner of Section C 9/ of Area 2 was probably the original terminus of the 2-circuit 110-kv powerline which ties the Zaozernyy Complex to the Dodonovo Complex. This substation has been recently expanded. A control and low-voltage switching building has been added and a third larger transformer installed on its west side. It is difficult to ascertain from the available photography exactly how the circuits have been re-arranged. A possible arrangement of this circuitry is shown on Figure 2.

A substation having two 110-kv step-down transformers is located in Area 3 north of the steamplant (Figure 15). 9/ Power is now received from Kamala Substation over a 2-circuit 110-kv powerline. Probably only one of these circuits is tied into the substation. The other circuit probably bypasses the substation and continues on to Area 4 because there do not appear to be sufficient switching

positions in the substation to handle 3 incoming circuits and 2 circuits to the 2 transformers.

A possible substation has been observed in the northwest corner of Section G of Area 4 (Figure 14). 9/ A possible control and low-voltage switching building has also been observed there.

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